2.0 Marine Protected Areas: Background and Basic Concepts

With world-wide recognition of significant threats and impacts to ocean resources, the marine environment has in recent years attracted strong attention from conservationists at global, regional and local levels. Under the pressures of burgeoning coastal populations and ever-increasing marine resource use, evidence of coastal degradation has mounted (Agardy 1994a). Fish kills, algal blooms, coral reef degradation, decreasing commercial fish catches, chronic indirect degradation of nearshore habitats, loss of biodiversity, extirpation of species, and use conflicts (Agardy 1997) offer but a short list of warning signs to which the world has become increasingly aware. In step with this movement, increasing attention has been directed toward the relatively new idea of establishing marine protected areas as a key tool for marine conservation and management.

As a relatively new development, however, MPAs are still considered experimental in many respects. Definitions, concepts, models, and other aspects associated with MPAs vary widely and are evolving rapidly. Based on a review of literature ranging from agreed upon principles to the latest thinking, this section discusses some basic concepts associated with MPAs. A definition for MPAs is provided, along with an explanation of various management models for MPAs. The growth of MPAs worldwide is noted, and a discussion of objectives and benefits associated with MPAs is presented. Additionally, constraints and limits of MPAs are discussed.

2.1 What Are Marine Protected Areas?

2.1.1 Marine Protected Area Defined

Marine protected areas (MPAs) are areas specially managed to protect species, habitats and ecosystems. The most generally accepted definition of a marine protected area is that originally developed in 1987 at the Fourth World Wilderness Congress in Denver, Colorado, and subsequently adopted by the World Conservation Union (IUCN) in 1988 at its 17th General Assembly (IUCN 1988; Kelleher and Kenchington 1992). According to this definition, a marine protected area is:

> *Any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment.*

This broad definition implies that a wide variety of protected area types are considered MPAs. Such areas have been described as marine reserves, preserves, parks, sanctuaries, refuges, wilderness areas, protected areas and many other titles (Gubbay 1995; Potter 1994), and are equally varied in purpose. However, regardless of varieties in name, size, design, purpose or other elements, all MPAs have in common the setting aside of a marine area from otherwise unrestricted human activities.

2.1.2 MPA Management Models

MPAs may range from small "no-intrusion" areas, to "no-take" reserves prohibiting all consumptive human uses, to large multiple-use areas targeting a whole range of conservation, economic and social objectives, and innumerable possibilities in-between. It is helpful to understand the basic concepts behind the more commonly established and/or discussed management models associated with MPAs.

Models for MPAs may be broadly categorized as belonging to one of the following three management schemes:

- No-take areas
- Feature-specific
- Multiple use

No-take Areas

No-take areas are places where the extraction of all marine life is prohibited. These restrictions apply to commercial as well as recreational or traditional fishing or collection of biota, and are aimed at directly addressing issues related to harvest or exploitation of marine resources and related impacts. Other activities at such MPAs are often limited, such as research, education and non-consumptive uses such as SCUBA diving or snorkeling.

No-take areas are not as restrictive as "no-intrusion" areas, where humans are prohibited from entry in order to protect sensitive resources such as breeding sites for seabirds or marine mammals. However, no-take areas are by definition more restrictive than "harvest refugia" areas, fishery management areas where one or more fished species are protected from harvest; no-take areas preclude the extraction of all marine life, whether fished or not.

No-take MPAs are established for a variety of reasons, including scientific research, biodiversity protection, protection of endangered species or habitats, protection of critical fisheries habitats or stocks and protection of representative ecosystems (de Macedo 1995). Many of the benefits attributed to MPAs (see Section 2.3.2) are associated with no-take areas.

While many countries have established no-take MPAs, these types of MPAs are generally not as widespread as other models that allow for consumptive uses. Regionally, there are two no-take MPAs in Canada (MLSS 1997), likely fewer than ten in California (Marx 1997), and just one in Puget Sound (as will be discussed in Section 4.1.2). No-take areas are also generally smaller in size than many other MPAs, although they may be included as zones within larger multiple-use MPAs.

No-take areas often require strong regulations directed at prohibiting harvest of marine life. Alternatively, such restrictions may be upheld through the voluntary support and cooperation of users (Gubbay and Welton 1995).

Feature-Specific MPAs

MPAs are also designed for a multitude of specific resource or activity management purposes. Examples include MPAs established and managed specifically to protect areas for:

- purely recreational features or attractions
- protection of historic, archaeological or cultural heritage features
- specific fishery management objectives (such as harvest refugia for a single species or groups of species)
- scientific research use

The nature of such MPAs, their design, regulatory framework, and other factors varies from site to site based on the primary objectives. Use restrictions tend to be less strict than no-take zones, and are generally directed toward control of only those activities that might threaten the MPA's protected feature.

Multiple Use MPAs

The latest generation of MPAs are now largely being designed as multiple use reserves (Agardy 1994a). These MPAs consider the needs of many different stakeholders and provide a mechanism for addressing a wide range of marine resource and habitat management dilemmas (Eichbaum et al. 1996; Agardy 1994a). Multiple use MPAs are generally larger than no-take MPAs, and many incorporate zoning systems to structure protective and permissive management regimes. In addition to accommodating many uses, larger-sized multiple use MPAs may provide increased ability to protect mobile organisms over wider geographic areas, as well as opportunities to address threats such as pollution and other impacts often associated with coastal development (Sobel 1993). The Florida Keys National Marine Sanctuary and the Great Barrier Reef Marine Park in Australia are two large-site examples of this model of MPA.

Zoning schemes are often employed at multiple use MPAs to protect areas most ecologically critical, sensitive or amenable to monitoring and evaluation (Agardy 1994a). Zoning can also help to prevent conflict between several uses of the marine environment, such as recreation, tourism, and fishing. No-take or no-intrusion areas may represent possible zone types, as well as recreational areas or resource harvest locations. Temporal separation of allowed and restricted activities is another method used to manage potentially conflicting uses (Ticco 1993).

However, not all MPAs accommodating multiple uses are large or employ zoning schemes. "Multiple use" is often interpreted and implemented such that multiple activities are allowed to take place in the same area. This is an approach which allows for many users but does not necessarily provide special protection to sensitive or critical zones (de Macedo 1995; Ballentine 1991).

2.2 Growth of Marine Protected Areas

Marine conservation lags terrestrial conservation by roughly two decades (Agardy, 1994a; Norse, 1993), and marine protected areas and their conceptual framework have trailed their terrestrial counterparts by nearly a century (Lien and Graham 1985; Norse 1993). Only in the last 20 years has the concept of protecting certain marine areas become widely accepted (Norse 1993. Given this, it is perhaps not surprising that global terrestrial protected areas are said to outnumber marine protected areas by 7 to 1 (WRI, IUCN and UNEP 1992). Furthermore, while the world's area of sea and seabed is more than two and one half times as large as the total area of land masses, less than one percent of this marine environment is within established protected areas (Kelleher and Kenchington 1992). From this, the obvious point taken is that the extent to which the marine environment is conserved through the application of protected areas lags far behind the terrestrial environment (Kelleher and Kenchington 1992).

Recent decades have seen considerable progress in the establishment of MPAs throughout the world. In 1970, it was estimated that 118 MPAs existed in 27 nations (Kelleher and Kenchington 1992). By 1985, De Silva et al. (1986) reported 430 MPAs designated by 69 nations, and 298 proposals under consideration. The most recent global inventory of MPAs by Kelleher et al. (1995) indicates that there are now at least 1,306 MPAs, with a median size of 1,584 hectares of subtidal area.

Such global inventories do not include many state, provincial and locally established MPAs. At these levels, mechanisms for the development and management of MPAs are so numerous and diffuse that comprehensive identification of programs and smaller protected areas has not been accomplished (Crosby, personal communication 1996).

Closer to the State of Washington, however, the growth and status of MPAs in California and British Columbia are of recent and ongoing independent study. Work to date has recognized 104 MPAs in California (McArdle 1997) and 109 in British Columbia (Lewis 1995; MLSS 1997).

2.3 Objectives and Benefits of Marine Protected Areas

MPAs are established to meet many different goals and objectives, and as such they are associated with a wide variety of benefits. This section lists common objectives for which MPAs are designated, and provides a brief review of some of the benefits linked to MPAs.

2.3.1 MPA Objectives

MPAs have been designated for numerous reasons to fulfill a variety of objectives. A list of various objectives for which MPAs around the world are most commonly designated is presented at **Table 1**.

Table 1. Commonly Cited Objectives for the Establishment of MPAs

- Maintain Biodiversity
- Promote Research
- Education/Training
- Conserve Habitat/Biota
- Baseline Monitoring Areas
- Protect Rare/Important Species
- Promote/Control Tourism/Recreation
- Promote Sustainable Development
- Recolonize Exploited Areas
- Coastal Protection
- Alternative Environmental Economic Arguments
- Aesthetic Value
- Protect Historical/Cultural Sites
- Political Reasons
- Intrinsic Absolute Value

Source: (Jones 1995)

2.3.2 MPA Benefits

Closely related to the objectives commonly established for MPAs, the benefits associated with marine protected areas are numerous and diverse, ranging from ecological to social and economic. This section provides a brief review of some of the benefits linked to MPAs. MPA benefits can be divided into five broad categories (Sobel 1996; BC Parks 1997):

- Protect biodiversity and ecosystem structure, function and integrity
- Improve fishery yields and management
- Expand knowledge and understanding of marine ecosystems
- Provide recreation and tourism opportunities
- Provide socio-economic benefits for coastal communities

Protect Biodiversity and Ecosystem Structure, Function and Integrity

Through the establishment of no-take areas or harvest refugia, MPAs can protect marine biodiversity at genetic, species and ecosystem levels by protecting endangered species, critical habitats, seed banks and sources of plant and animal recruits (Agardy 1994a; Eichbaum et al. 1996).

The preservation of genetic diversity is a potentially significant benefit of MPAs. In a review of numerous studies, Dugan and Davis (1993) note that while fishing pressure tends to select for small, early-maturing, slow-growing fish and invertebrates, harvest refugia may counteract this effect by helping to preserve more of the natural genetic diversity of a stock through restricting fishery-based selection of certain genotypes. Additionally, genetic diversity may be protected by MPAs that help guard against the loss and degradation of nearshore habitats.

A number of studies have shown species richness to be increased in marine reserves and harvest refugia areas (see Bohnsack 1993; Dugan and Davis 1993; Roberts and Polunin 1993). MPAs can also protect biodiversity at the species level by protecting key predatory species, which help maintain community structure.

MPAs can help safeguard ecosystem diversity by protecting both unique systems, such as those high in biological diversity, as well as larger areas of representative biogeographical units. Ecosystem function and integrity is maintained through protection of essential marine ecological processes, such as the movement of water, food and organisms and the transfer of nutrients between trophic levels, which can be controlled in MPAs through the management of activities that disrupt them or damage the environment (Salm and Clark 1984).

MPAs managed as no-take areas can help to maintain community structure not only through the protection of species and preservation of genetic biodiversity, but also by eliminating the physical damage to habitat that can be caused by the impacts of fishing gear. Such protection can maximize the resilience of an MPA's marine ecosystem to external stresses (BC Parks 1997).

Improve Fishery Yields and Management

MPAs that incorporate no-take zones or harvest refugia can ensure the continuance of fisheries by protecting spawning stocks from exploitation (Bohnsack 1993). In this sense, MPAs can insure against stock collapse by providing a hedge against the risk and uncertainties of traditional fishery management or chance environmental events. Furthermore, in the event of such a collapse, MPAs can assist in the rebuilding of depleted stocks faster than would otherwise be possible (Bohnsack 1993). Additionally, such MPAs can help reduce or eliminate incidental by-catch mortality and protect vulnerable or declining species.

Various studies have shown or proposed the potential for an increase in abundance, average size and age, reproductive output and recruitment of target fishery species in marine reserves (Dugan and Davis 1993). Of particular note to this study, Palsson and Pacunski (1995) observed greater abundance and larger sizes of select bottomfish species at Puget Sound harvest refugia MPAs when compared to fished sites. Besides target species effects within harvest refugia, the spill-over of protected area adults, juveniles, eggs and larvae offers the potential to maintain or improve fishery yields in areas adjacent to MPAs.

In addition to increased fishery yields, MPAs can provide other benefits as a fishery management tool. Among these are simplified enforcement, enhanced public awareness and acceptance, reduced data collection needs, and increased fairness and equity (South Atlantic Fishery Management Council 1990; Bohnsack 1993; Agardy 1994b; de Macedo 1995).

While the above discussion highlights some of the more frequently mentioned potential fisheries benefits linked to MPAs, many more have been noted by researchers and scientists. The summary of a recent workshop in British Columbia, Canada focusing on the Design and Monitoring of Marine Reserves, produced a fairly comprehensive tabular list of the potential fishery benefits of no-take marine protected areas (University of British Columbia Fisheries Centre 1997). **Table 2** presents this listing.

Table 2. Potential Fishery Benefits of Marine Reserves (No-Take MPAs)

- Increase abundance of overfished stocks inside reserves
- Increase abundance of overfished stocks outside reserves
- Allow increased fishing mortality outside of reserves
- Reduce overfishing of vulnerable species
- Reduce bycatch mortality inside reserves
- Simplify enforcement and compliance
- Reduce conflicts within and among sectors of users
- Maintain sport trophy fisheries
- Maintain diversity of fishing opportunities
- Provide some resource protection without data or other information
- Benefit reproduction by:
    - Increasing spawning stock biomass
    - Increasing spawning stock density
    - Providing undisturbed spawning conditions and habitats
    - Increasing spawning potential and stock fecundity
    - Increasing egg and larval production
    - Enhancing recruitment
- Export juveniles and adults to fishing grounds
- Reduce chance of recruitment overfishing
- Accelerate stock recovery after collapse
- Facilitate stakeholder involvement in fisheries management
- Provide data for improved fisheries management
- Increase public understanding and acceptance of fishery management
- Protection of intraspecific genetics from fishery selection
- Reduce variance in yield
- Reduce impacts on fisheries of environmental variability
- Allow studies of basic fisheries biology
- Support marine [conservation] ethic
- Provide ecosystem level protection

Source: (University of British Columbia Fisheries Centre 1997)

Expand Knowledge and Understanding of Marine Ecosystems

MPAs provide important locations for conducting scientific research and monitoring, and for providing public and field training educational opportunities. The long-term study of natural and minimally disturbed MPAs can provide important baseline information that can be compared to other areas. Such comparisons provide greater understanding of the impacts of fishing and of fishery resources, including information about species behavior, social organization, the dynamics of harvested species and other elements useful for improving fishery management models (Bohnsack 1993). It is also possible to study long term environmental changes at reference MPAs that are difficult or impossible to investigate at disturbed areas, and in turn distinguish natural effects from those caused by human activities. From a management perspective, MPAs can also provide physically definable research grounds for some of the newest concepts in conservation biology, resource economics and management (Agardy 1994a, 268).

Many MPAs also provide excellent venues for educating the public about the marine environment. This service can raise public awareness of and appreciation for human impacts on these often misunderstood systems, and communicate the importance of stewardship and conservation. Public education can be delivered through on site interpretive programs such as guided walks, self-guided trails, aquaria and field trips (Salm and Clark 1984), as well as through the development of curricula for schools. As outdoor marine laboratories, MPAs can serve as focal points for the education of students of marine science and other disciplines.

Provide Recreation and Tourism Opportunities

MPAs often provide natural settings or managed zones attractive to tourism and recreational activities. MPAs can provide for the protection of special recreational features in the marine environment, such as boat moorage and anchorage areas, beaches, wildlife viewing areas, recreational fishing or shellfishing areas, SCUBA diving areas, swimming and snorkeling areas. Additionally, environmentally-aware tourists may be attracted to MPAs for the educational opportunities they provide, such as learning about marine ecology, marine archaeology or local indigenous cultures and their use of the sea (Agardy 1993).

"No-take" MPAs or zones within MPAs can benefit non-consumptive recreational users such as snorkelers and SCUBA divers, and have been shown to be popular with these visitors (Ballentine 1991). Additionally, with zoning or other management measures aimed at facilitating multiple stakeholders, MPAs can help assure recreational uses while controlling for user conflicts and protecting marine resources and values.

Provide Socio-Economic Benefits for Coastal Communities

MPAs contain valuable economic resources important to local and national economies (Dixon 1993). Tourism and recreation activities accommodated through use of an MPA can provide direct and significant financial benefits to local economies. Additional benefits include job creation associated with MPA activities, private sector revenues (hotels, dive operators, guides, etc.), government revenue (income taxes, business taxes and taxes levied on tourists) and direct revenue from park user fees (de Macedo 1995; Dixon et al. 1993). Although not as easy to measure for MPAs, their role in maintaining the sustainability of commercial, sport and traditional culture fisheries represents an important MPA benefit. Other MPA economic benefits are difficult to express in monetary terms. Examples include the economic value of biological resources and environmental services, such as coastal protection from wave erosion or floods provided by a protected reef or estuary (Dixon 1993).

2.4 MPA Constraints and Challenges

While MPAs are associated with numerous benefits (as described in Section 2.3.2), there are also constraints to the broad applicability of this approach, and many challenges limit their potential for success. It is important to recognize that MPAs are but one component in a broader scheme of marine conservation strategies. An MPA itself, for example, cannot provide direct protection to an area from external pollution sources, or from the effects of damaging activities in the wider marine environment.

Similarly, MPAs alone may be ineffective or of highly limited value for protecting widespread or migratory species. For example, target fishery species may forage or migrate outside protected zones diurnally or seasonally where they may be harvested or denied critical habitat (Dugan and Davis 1993). In general, because MPAs are likely to cover only a small percentage of coastline and marine area, they are not able to address many marine resource impacts, problems and management needs extending beyond or originating outside of their bounds.

Successful MPA site design, selection and management is complicated by uncertainty and the limits of scientific knowledge about the marine environment. In considering harvest refugia, for example, limited knowledge about population replacement rates, dynamics, recruitment patterns, and impacts of fishing pressure on ecosystem function can pose impediments to successful MPA establishment (Agardy 1994b).

Reliance upon terrestrial protected area models and experience can limit MPA development and effectiveness, and underscores the differences between the dynamics and scales of terrestrial and marine systems (Agardy 1994a). Unlike most terrestrial parks or protected areas, MPAs are faced with the unique challenge of protecting, monitoring and raising awareness about "hidden" or submerged ecosystems. The fluid marine environment, with its currents, tides and three-dimensionality, presents very distinct MPA challenges when compared with terrestrial areas (Eichbaum et al. 1996). For example, enforcement and boundary demarcation of MPAs, especially in open water areas, can be more difficult than similar efforts on land.

Social constraints may also limit the applicability of MPAs. Marine parks or closed fishery areas may be perceived as exclusionary or elitist — off limits to local users and benefiting only temporary visitors (Agardy 1994a; 1994b). Public acceptance is also made difficult because many of the benefits of MPAs (as previously mentioned), such as resource renewal, sustainability of ecosystem function, and long term socio-economic welfare, are hard to quantify and slow to be realized (Agardy 1994a).